1. PROCESS INFORMATION

The paste plant produces the anodes that are used in the potlines. Liquid pitch, green scrap and coke are combined and heated. The pitch fumes from this process are captured and passed through a dry coke scrubber with a baghouse. A vibratory former is utilized to produce the green (unbaked) anodes which are then baked in the carbon bake furnaces. Carbon Bake phase 1, 2 and 3 each have three areas: receiving and storage of green carbon anode blocks from the anode press plant, baking the blocks, and cleaning, storing, and transferring the blocks to Carbon Rodding.

Carbon Bake 1 was constructed and began operation in 1971 and Carbon Bake 2 began operation in 1976. The major difference between Carbon Bake 1 and 2 and Carbon Bake 3 is the physical appearance. Carbon Bake 3 pits are elevated, the bottom of the pits are at ground level and Carbon Bake 1 and 2 pits are below ground level, the top of the pits are at ground level.

Green anodes are allowed to cool before being placed in the furnace pits to bake. Carbon Bake 1 and 2 each have 36 sections. Each section in Carbon Bake 1 and 2 has six (6) pits and has a capacity of 12 anodes. Carbon Bake 3 has a total of 46 sections. Each section in Carbon Bake 3 has seven (7) pits and has a capacity of 10 anodes.

The position of the exhaust manifold downstream from the burners determines the number of sections being fired. Present facilities allow the use of natural gas or a propane mixture.

The anodes in each section are "baked" together in what is referred to as a firing cycle. The section is gradually raised to a temperature in excess of 1100°C over a period of 6 to 7 days. This is followed by a cooling period of 4 to 6 days, so the total cycle requires 11 to 13 days before the anodes are removed, cleaned, and made ready for use in the potlines.

Once full operation of a furnace is achieved, a new firing cycle is begun at regular intervals. The length of these intervals may vary according to the schedule being used, but generally is 24 to 28 hours.

2. PRODUCTION RATE OF GREEN ANODE MATERIAL

Prior to October 1999, the production rate used to calculate emissions was based on baked anode weight. In October 1999, the NESHAP (National Emission Standard for Hazardous Air Pollutants) came into effect. Since that time, the production rate for Carbon Bake is calculated from green anode material used in the production of baked anodes. The production rate for the Green Mill (anode paste plant) is calculated from the total paste (green anode material) produced. The numbers used in these calculations are obtained from the carbon department.

The average green anode weight for the month in pounds is multiplied by the number of blocks baked for the month. The result is divided by the number of days in the month. An Excel file, “Green anode baked & produced YYYY” is used for calculating the green anodes baked and the total paste (green anodes) produced in pounds in the carbon area per day.

3. ENVIRONMENTAL CONTROLS

The pits and sections are constructed in an arrangement called a "ring" furnace. There is a crossover duct on the west and east ends for hot flue gases. The exhaust is piped eastward down each side and comes together in a plenum outside the building before going to the dry scrubbers.

The hot gases pass only through the brickwork flues around the pits so very little pollutants come from the anodes. However, as the flues age and expand, some of the volatiles from the anode and the extremely fine portion of the coke packing material may be entrained into the exhaust. Due to the extremely high temperatures of the exhaust, the majority of this material is burned inside the ductwork before it reaches the control equipment. This is the reason no primary controls were installed on baking furnaces at the time Carbon Bake 1 was constructed. No auxiliary control devices would be required if particulates were the only pollutants of concern. However, Federal New Source Performance Standards (NSPS 40 CFR Part 60), mandating the control of fluoride emissions, necessitated installation of emission control equipment. On October 31, 1998, the exhaust from Carbon Bake 1 was routed to a plenum along with the exhaust from Carbon Bake 2 and 3. Since that time, the exhaust from all three phases leaves the plenum and is scrubbed through the operating scrubbers.

The air cleaning equipment utilized by M7M in Carbon Bake is commonly referred to in the industry as a "dry scrubber system." This system design has been in operation in Carbon Bake 2 since its construction in 1976 and in Carbon Bake 3, as necessitated by the New Source Performance Standards. Figure 2 shows the detail of a typical dry scrubber. The particulate portion of the dust-laden air from the fluidized bed is captured by the fabric bags in the upper portion of the scrubber. This part is very common technology, as bag houses have been used by various industries to remove dust for many years. Each scrubber has a total of 780 bags, 195 in each of the four compartments, which are modularized for easier maintenance. Normal operations at M7M are with two units in each furnace operating at an approximate flow of 30,000 SCFM from each unit.

The unique feature of the scrubber units is the "fluid bed" of alumina, which also adsorbs or "scrubs" the gaseous pollutants from the air stream. The clean exhaust is vented into the atmosphere.

Flow rates are not determined from individual scrubbers on a routine basis. The normal method of control is by observation and alteration of fan motor amperage and pressure drops across the fluid bed and bag portions of each unit. For Carbon Bake 1 and 2, scrubbers 1 – 8, the total volumetric flow is calculated at the sample port prior to exhaust from the stack. For Carbon Bake 3, scrubbers 9-12, the total volumetric flow is calculated at the sample port locations downstream of the scrubbers just prior to exhaust from the stack.

The green mill also uses a "dry scrubber system" similar to the dry scrubber shown in Figure 2 but the material used to scrub the pitch emissions is fine dry material from baked butts and this material makes up the “fluid bed” which adsorbs or “scrubs” the pitch fumes from the air stream. The particulate portion of the dust-laden air from the fluidized bed is captured by the fabric bags in the upper portion of the scrubber. The clean exhaust is vented into the atmosphere.

4. SAMPLING STRATEGIES AND PORT LOCATIONS

Carbon Bake air control system is grouped in phases. Scrubbers 1-4 are designed as phase 1, scrubbers 5-8 are designated as phase 2 and scrubbers 9-12 are designated as phase 3. Since Magnitude 7 Metals began operation in 2018, only scrubbers 5–12 are in operation.

Phase	Scrubber number	In operation at Magnitude 7 Metals	Number of stacks
1	1	No	16
1	2	No	16
1	3	No	16
1	4	No	16
2	5	Yes	16
2	6	Yes	16
2	7	Yes	16
2	8	Yes	16
3	9	Yes	1
3	10	Yes	1
3	11	Yes	1
3	12	Yes	1

Scrubbers 1– 8 are sampled once per year for fluoride and polycyclic organic matter. Total particulate is required once on each scrubber and can be tested simultaneously with fluoride or polycyclic organic matter. Scrubbers 9 – 12 are sampled through the Carbon Bake 3 ductwork and must have three runs per year for fluoride and polycyclic organic matter. Total particulate is required on three runs and can be tested simultaneously with fluoride or polycyclic organic matter.

4.1. Carbon Bake 1 and 2

Carbon Bake 1 and 2 scrubbers are located northeast and east of the furnace building. Figure 3 shows the location of Carbon Bake 2 scrubbers and a detail of the exhaust system. Figure 4 shows the sample port for each stack is 8 duct diameters downstream and 2 duct diameters upstream from a disturbance. Figure 5 details the required number of traverse points for an EPA method stack sample on a single stack, Figures 6 and 7 identify the traverse points and how they were determined.

One stack of a scrubber is sampled along two traverses at 90 degrees to one another in a plane perpendicular to the flow direction. Eight sampling points (four points per traverse) represent the emission of the scrubber.

The total duct area of the scrubber sampled is calculated as the area of a single stack, times the number of stacks per module, times the number of modules per scrubber. Duct area calculations are shown in detail in Figure 4.

4.2. Carbon Bake 3

Unlike Carbon Bake 2, in which each scrubber vents directly to the atmosphere, Carbon Bake 3 scrubbers are run to a single duct which exhausts into a stack. The sampling ports for the Carbon Bake 3 exhaust are located in that common duct just east of the furnace building and just north of the Carbon Bake 2 and 3 scrubbers, as shown in Figure 8. Figure 9 shows the duct between the scrubbers and the stack and the position of the ports between disturbances in the duct. Figure 9 also shows the calculations for equivalent diameter. The diagram on Figure 5 details the required number of traverse points for a duct of this configuration, as well as the traverse point layout required and the sampling strategy used. Figure 10 shows the cross-section of the duct with the traverse points identified.

4.3. Green Mill

The coke scrubber captures and scrubs the pitch fumes generated from heating the pitch, green scrap and coke to form the anodes which exhausts into a stack. The sampling ports for the Green Mill exhaust is located on the top level of the Green Mill. Figure 11 shows the cross-section of the duct with the traverse points identified, the calculation of the duct area and the stack sampling point determination and Figure 12 shows the position of the ports between disturbances in the sampling duct.

Sampling strategies used for Carbon Bake and Green Mill

Location	Pollutant	Number of sampling points	Total time per test run	Minutes per point	Number of runs per year
Carbon Bake Phase 1 & 2 (Scrubbers 1 – 8)	Particulate and Fluoride	8	240 min. (4 hours)	30	1 on each scrubber *
Carbon Bake Phase 1 & 2 (Scrubbers 1 – 8)	Particulate and polycyclic organic matter	8	240 min. (4 hours)	30	1 on each scrubber *
Carbon Bake Phase 1 & 2 (Scrubbers 1 – 8)	Mercury	8	180 - 240 min.*	30	1 on each scrubber *
Carbon Bake Phase 3 (Scrubbers 9-12)	Particulate and Fluoride	30	300 min. (5 hours)	10	3
Carbon Bake Phase 3 (Scrubbers 9-12)	Particulate and polycyclic organic matter	30	300 min. (5 hours)	10	3
Carbon Bake Phase 3 (Scrubbers 9-12)	Mercury	30	180 - 240 min.*	6	3
Green Mill	Particulate	24	180 min. (3 hours)	7.5	3

*All test runs shall achieve >/+ 4 dscm/test.
**One run will be conducted on one stack for each scrubber in CB 1 and 2.

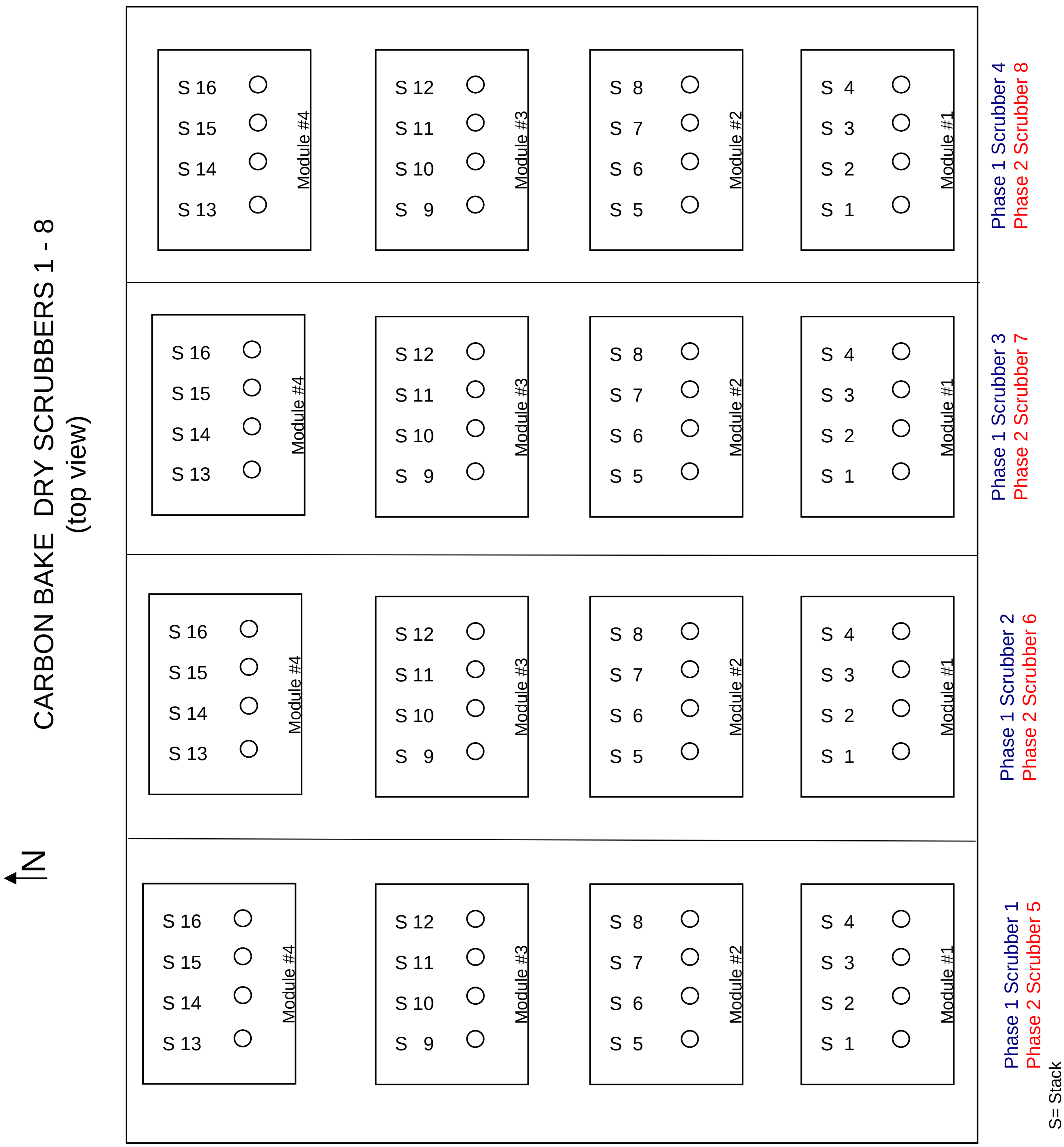


Figure 1 – Layout of Carbon Bake Phase 1 & 2 Scrubbers

TYPICAL DRY SCRUBBER

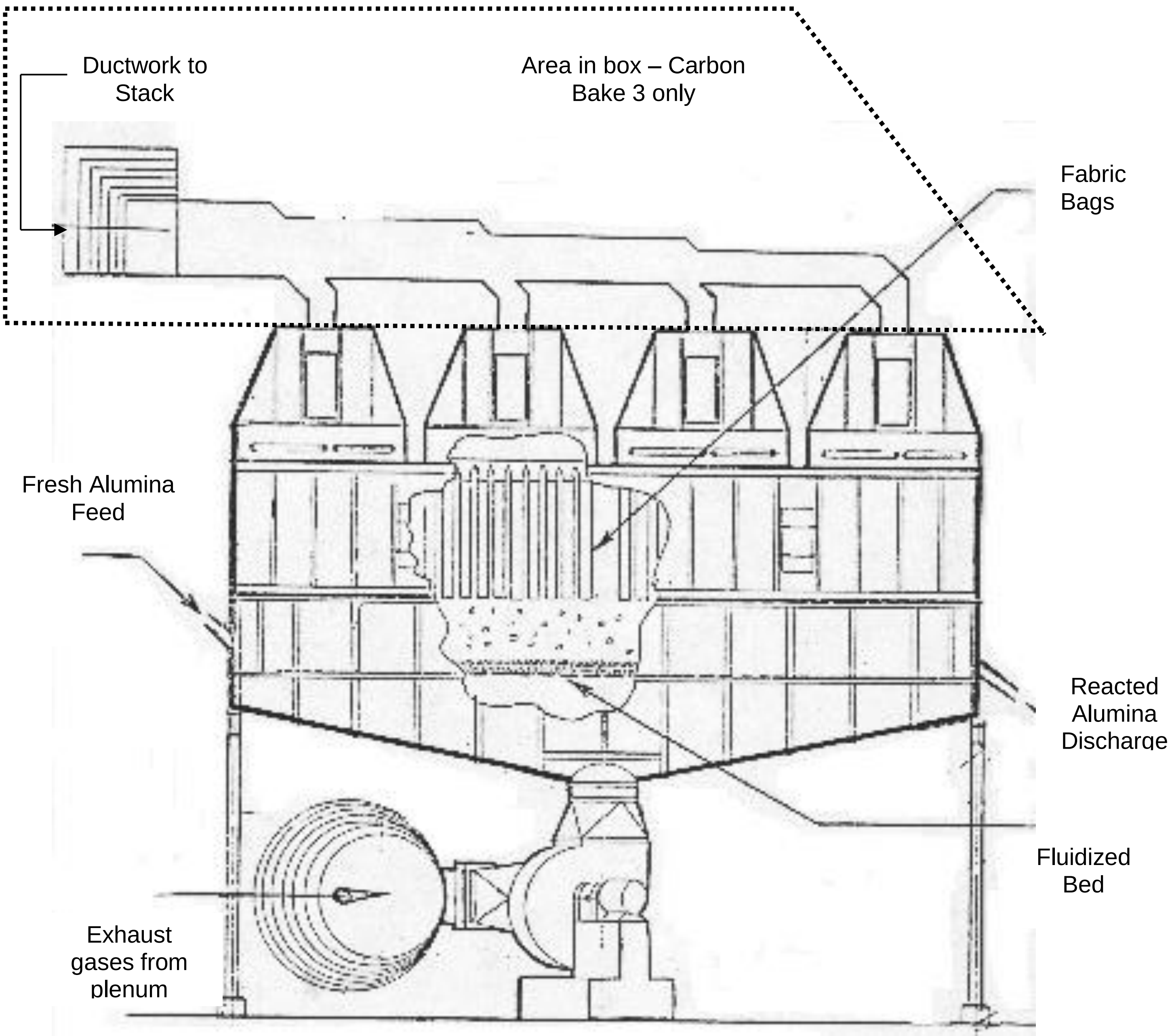


Figure 2

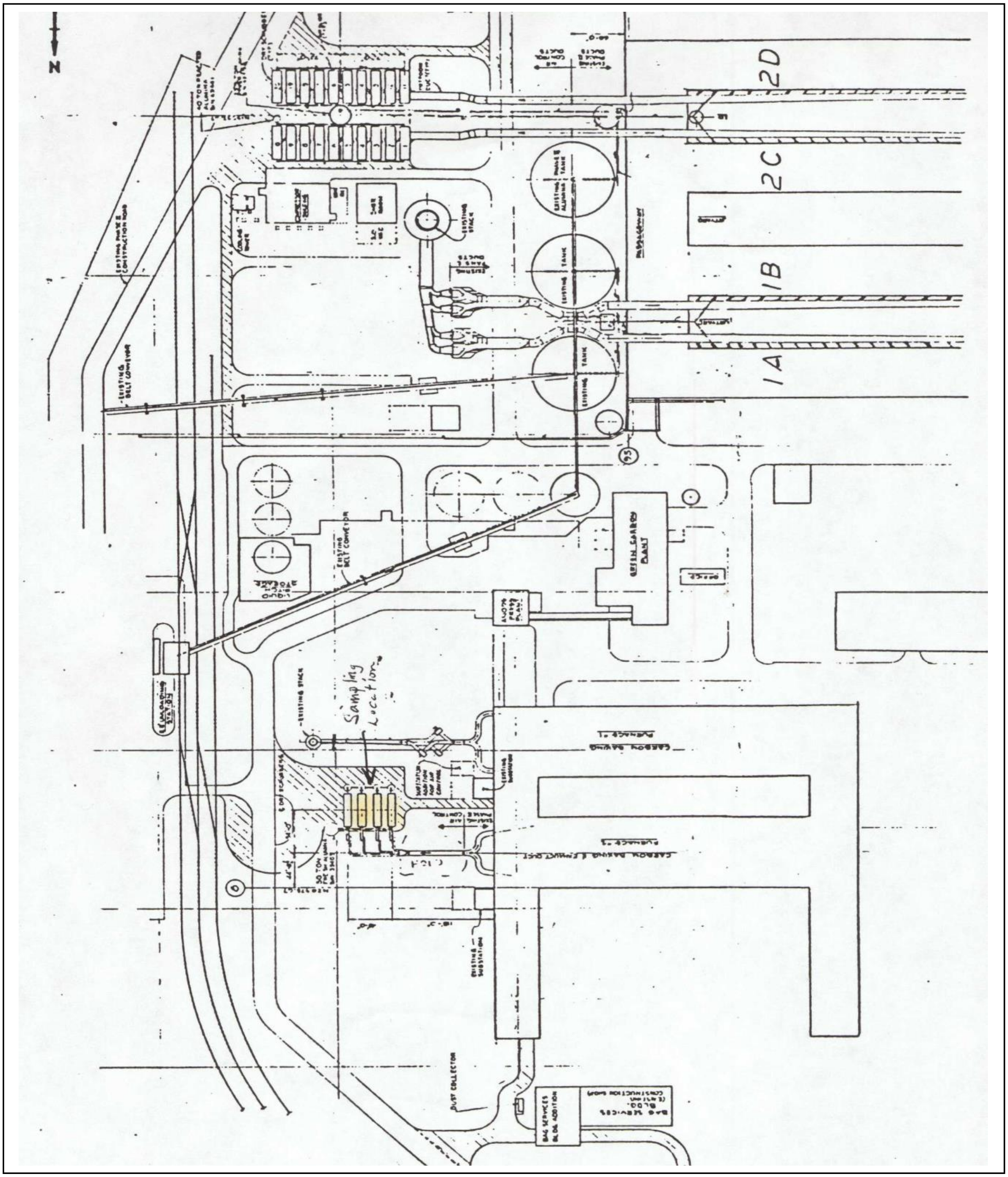


Figure 3

Inside Diameter of Duct = 11.75 inches = 1.0 foot

(2.0 ft. ÷ 1.0 ft.) = 2 duct diameters from upstream disturbance

(8.0 ft. ÷ 1.0 ft.) = 8 duct diameters from downstream disturbance

Area of a circle = π d^2 /4

Area of a Singe Duct = π x (Inside Diameter)^2 /4

= π x [(11.75 in.) x (1 ft./12 in.)]^2 /4

= 0.7530 ft^2

Total Duct Area = (Area of single duct) x (number of ducts per module) x (number of modules per scrubber)

= 0. 7530 ft^2 x 4 x 4

= 12.05 ft^2

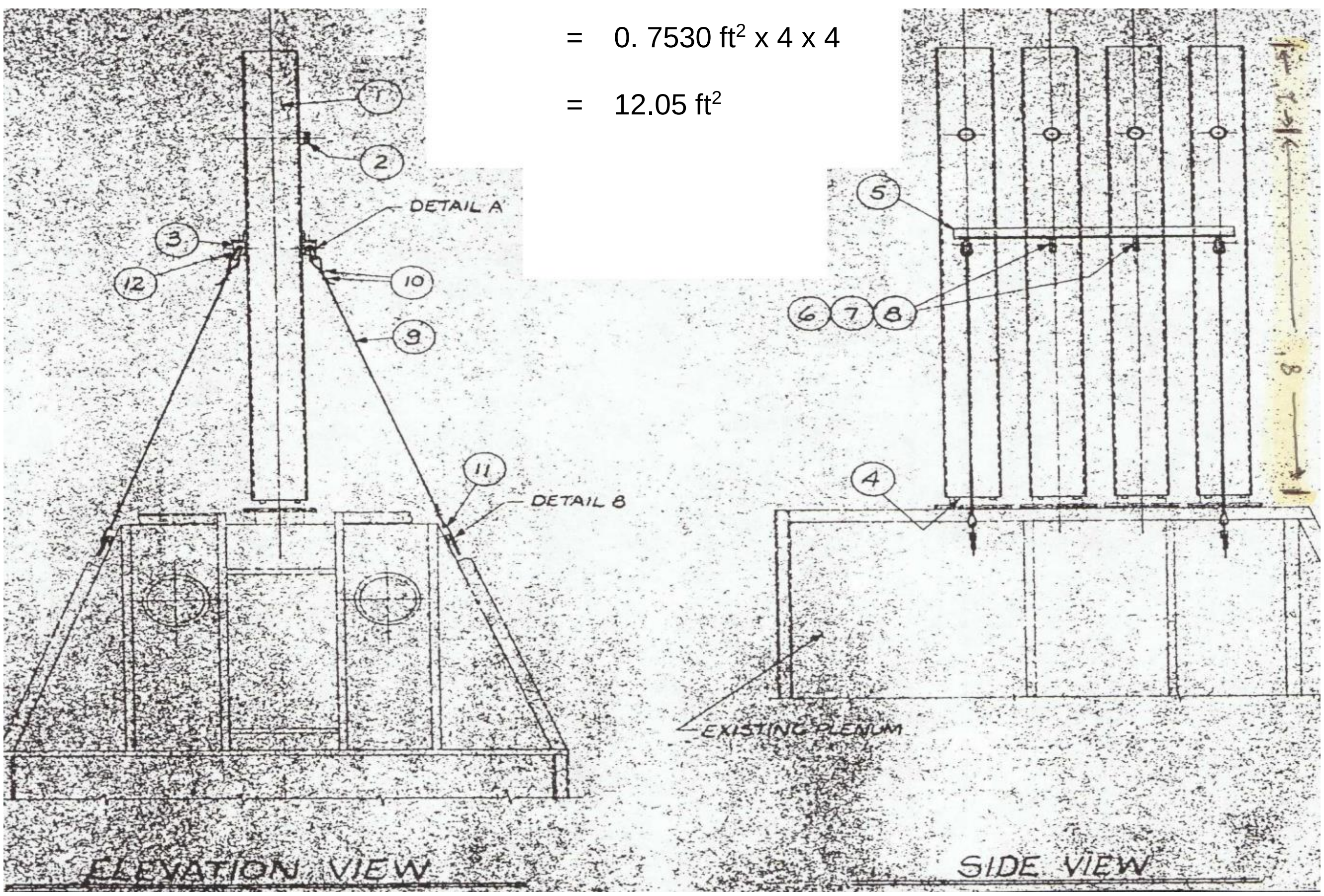


Figure 4

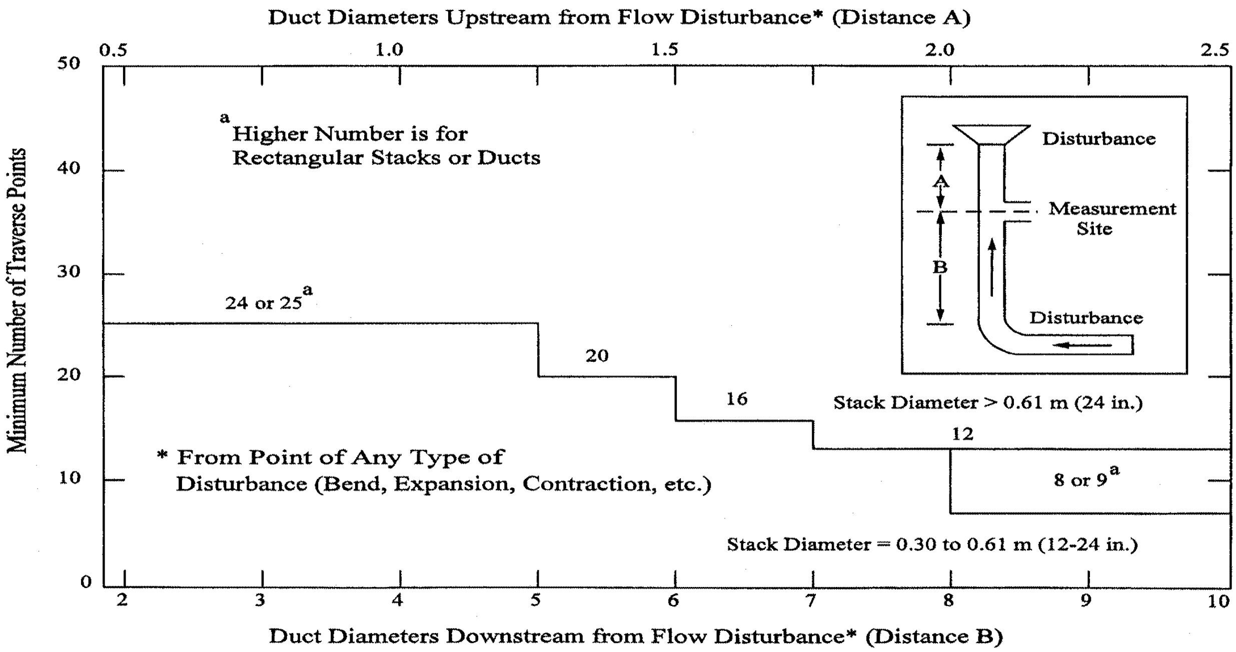

Duct Diameters Upstream from Flow Disturbance* (Distance A)
0.5
1.0
1.5
2.0
2.5
50
40
30
20
10
0
Minimum Number of Traverse Points
a Higher Number is for
Rectangular Stacks or Ducts
24 or 25 a
20
16
12
8 or 9 a
Disturbance
A
Measurement
Site
B
Disturbance
Stack Diameter > 0.61 m (24 in.)
* From Point of Any Type of
Disturbance (Bend, Expansion, Contraction, etc.)
Stack Diameter = 0.30 to 0.61 m (12-24 in.)
2
3
4
5
6
7
8
9
10
Duct Diameters Downstream from Flow Disturbance* (Distance B)

Figure 5

TABLE 1-2. LOCATION OF TRAVERSE POINTS IN CIRCULAR STACKS

[Percent of stack diameter from inside wall to traverse point]

Traverse point number on a diameter	Number of traverse points on a diameter—											
	2	4	6	8	10	12	14	16	18	20	22	24
1	14.6	6.7	4.4	3.2	2.6	2.1	1.8	1.6	1.4	1.3	1.1	1.1
2	85.4	25.0	14.6	10.5	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2
3		75.0	29.6	19.4	14.6	11.8	9.9	8.5	7.5	6.7	6.0	5.5
4		93.3	70.4	32.3	22.6	17.7	14.6	12.5	10.9	9.7	8.7	7.9
5			85.4	67.7	34.2	25.0	20.1	16.9	14.6	12.9	11.6	10.5
6			95.6	80.6	65.8	35.6	26.9	22.0	18.8	16.5	14.6	13.2
7				89.5	77.4	64.4	36.6	28.3	23.6	20.4	18.0	16.1
8				96.8	85.4	75.0	63.4	37.5	29.6	25.0	21.8	19.4
9					91.8	82.3	73.1	62.5	38.2	30.6	26.2	23.0
10					97.4	88.2	79.9	71.7	61.8	38.8	31.5	27.2
11						93.3	85.4	78.0	70.4	61.2	39.3	32.3
12						97.9	90.1	83.1	76.4	69.4	60.7	39.8
13							94.3	87.5	81.2	75.0	68.5	60.2
14							98.2	91.5	85.4	79.6	73.8	67.7
15								95.1	89.1	83.5	78.2	72.8
16								98.4	92.5	87.1	82.0	77.0
17									95.6	90.3	85.4	80.6
18									98.6	93.3	88.4	83.9
19										96.1	91.3	86.8
20										98.7	94.0	89.5
21											96.5	92.1
22											98.9	94.5
23												96.8
24												98.9

Figure 6 – Carbon Bake 1 & 2 Location of Traverse points

Point #	% Across diameter		Inside Diameter of Duct		Inches Across Diameter
1	6.7	x	11.75	=	0.8
2	25.0	x	11.75	=	2.9
3	75.0	x	11.75	=	8.8
4	93.3	x	11.75	=	11.3

Figure 7 – Carbon Bake 1 and 2 Stack Sampling point determination

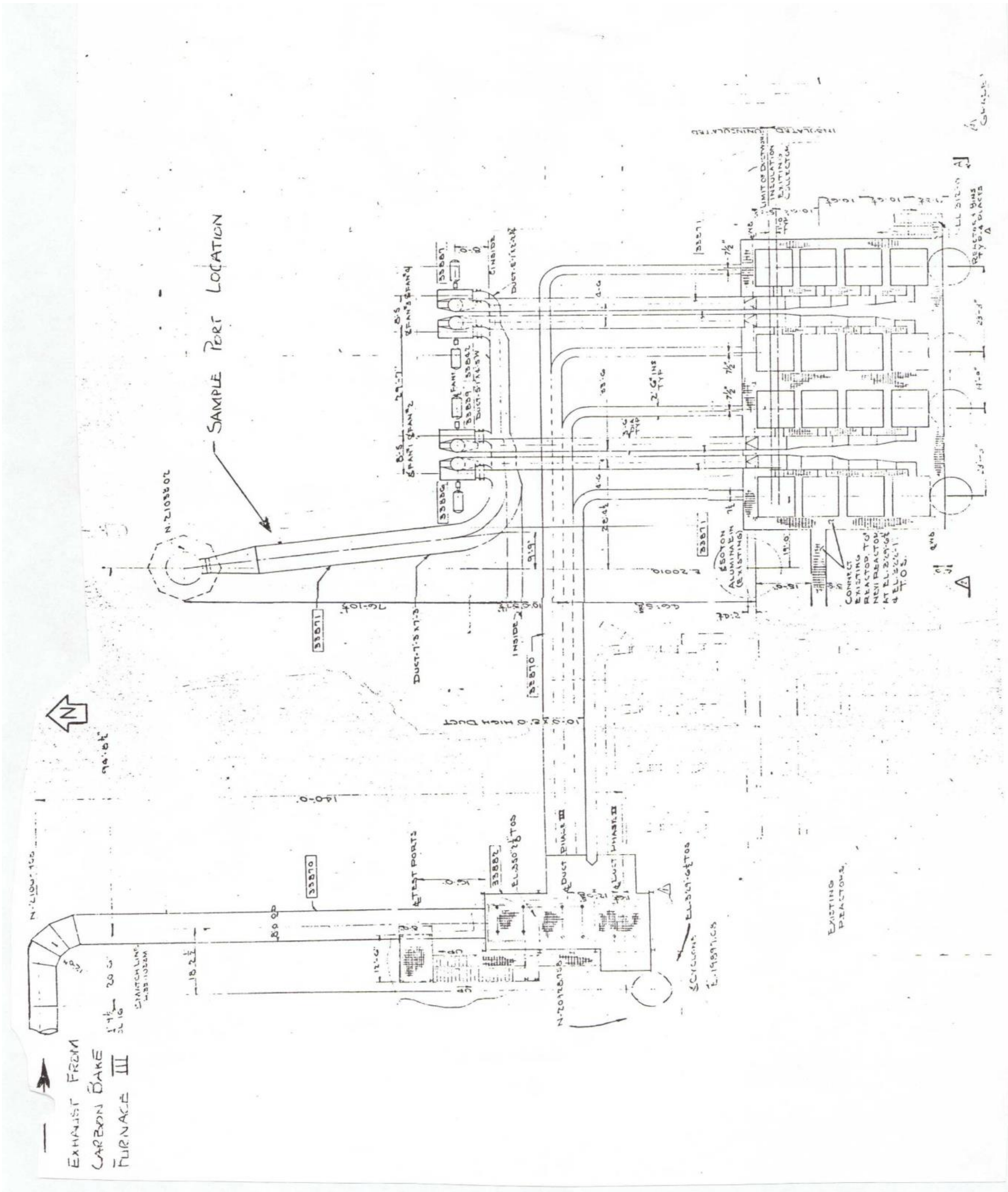
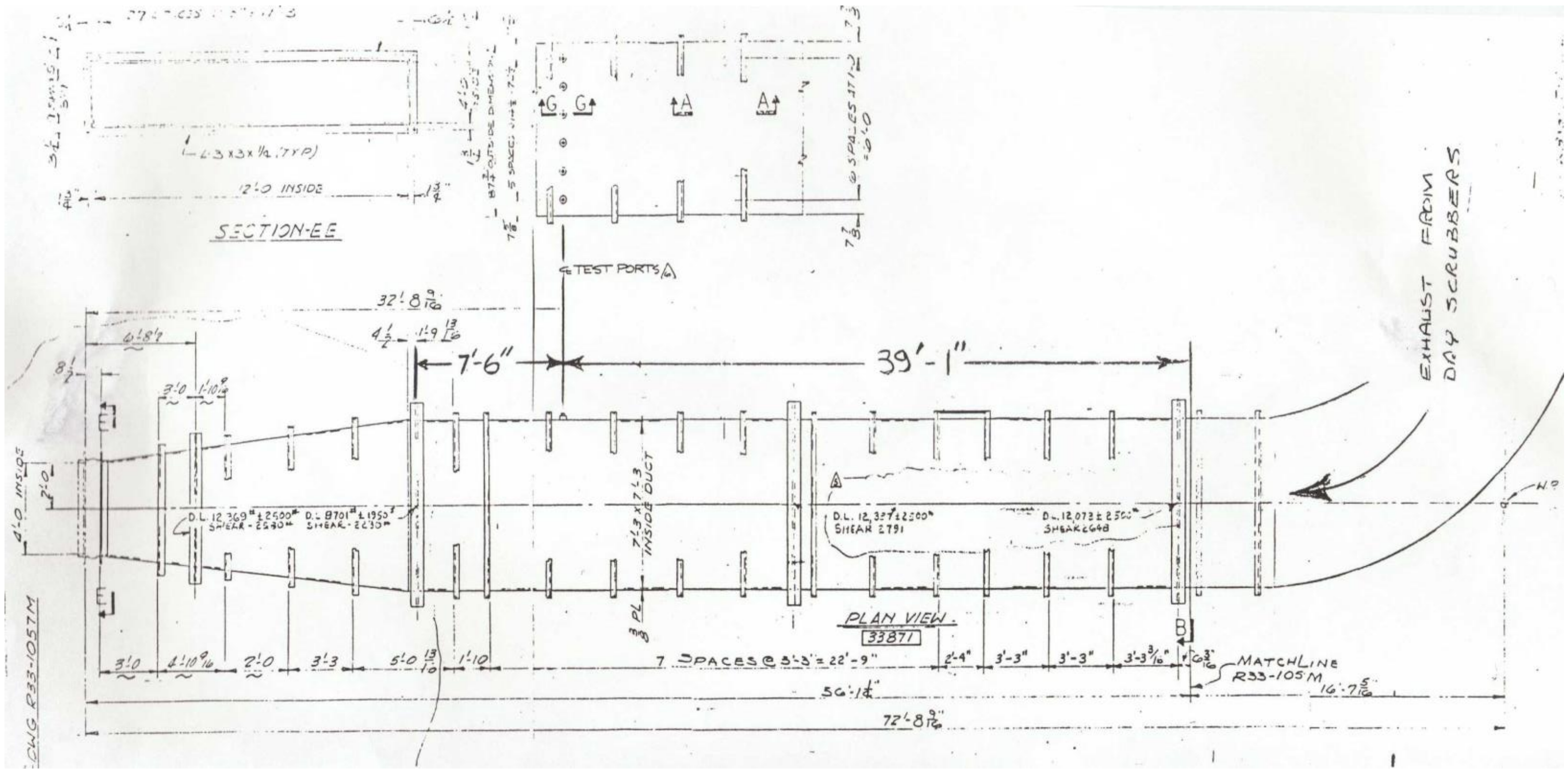

SAMPLE PORT LOCATION
EXHAUST FROM CARBON BAKE FURNACE III
EXISTING REACTORS

Figure 8



$$\text{Equivalent diameter} = \frac{2LW}{L + W} = \frac{(2)(7.25)(7.25)}{(7.25 + 7.25)} = \frac{105.12}{14.50} = 7.25$$

$$\frac{7.50}{7.25} = 1.03 \text{ diameters upstream from a disturbance}$$

$$\frac{39.08}{7.25} = 5.39 \text{ diameters downstream from a disturbance}$$

Figure 9 – Carbon Bake 3 Sample Port Location Details

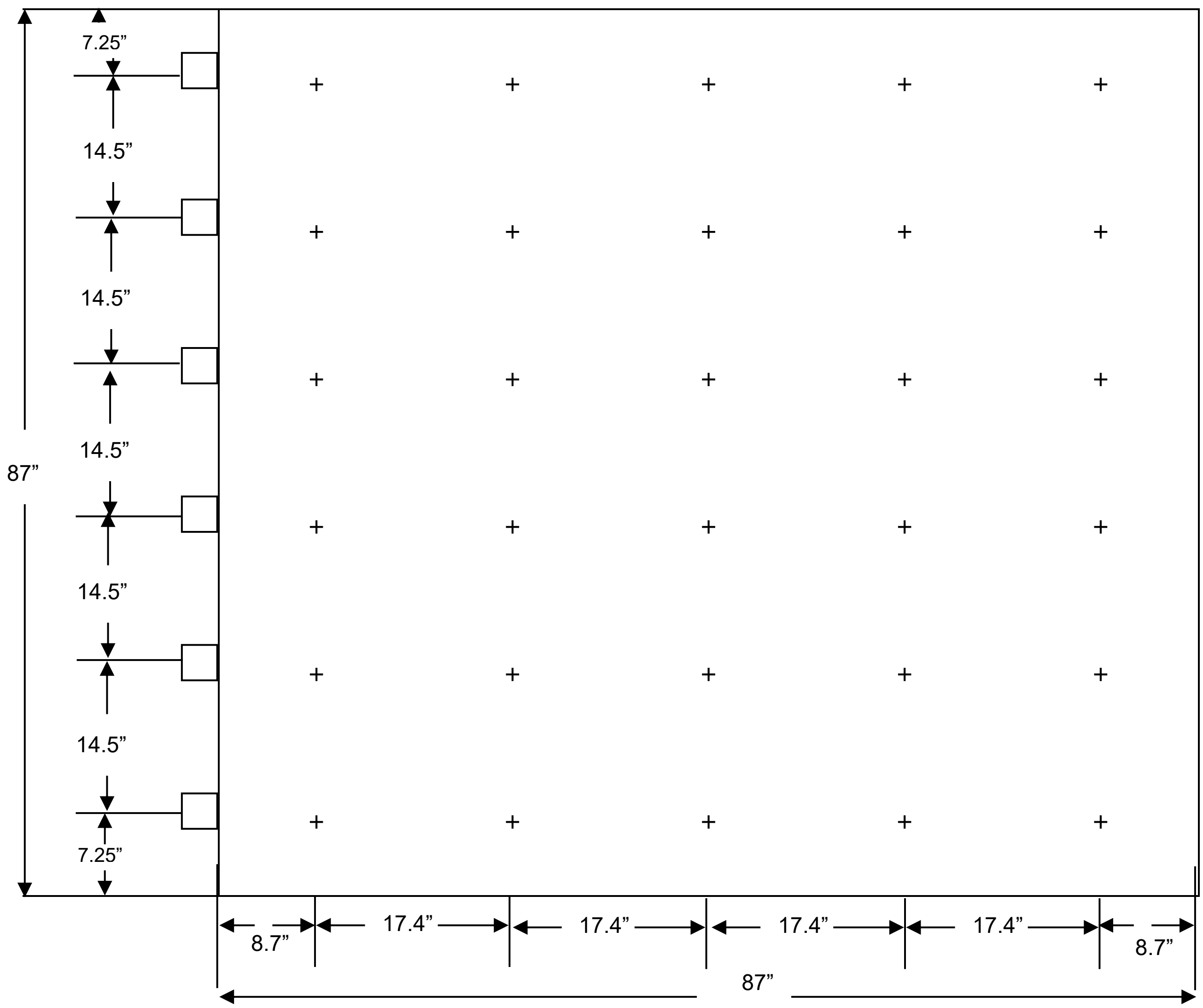


Figure 10: Cross sectional drawing of Carbon Bake 3 duct showing dimensions, sampling port locations and sampling points.

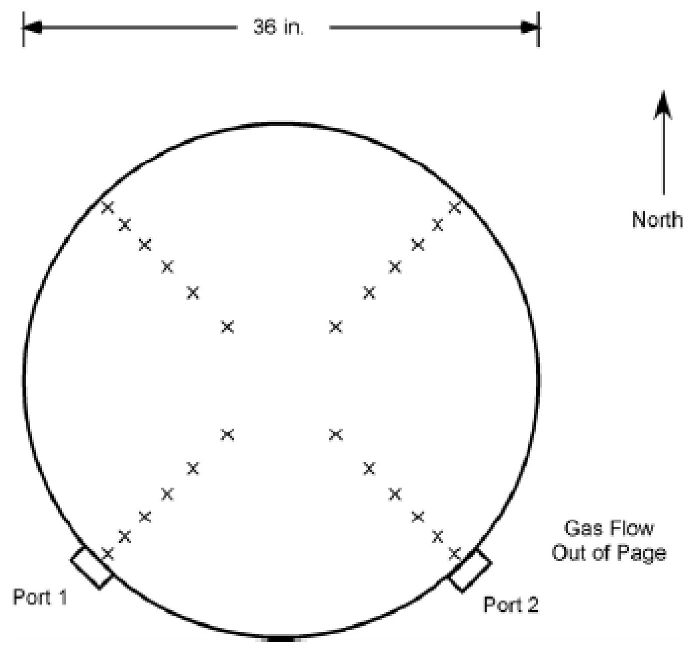
Inside Diameter of Duct = 36 inches = 3.0 foot

Area of a circle = π d^2 /4

Area of Duct = π x (Inside Diameter)^2 /4

= π x [(36 in.) x (1 ft./12 in.)]^2 /4

Total Duct Area = 7.07 ft^2



Sampling Point	Port to Point Distance (in.)
1	35.0
2	33.6
3	31.8
4	29.6
5	27.0
6	23.2
7	12.8
8	9.0
9	6.4
10	4.2
11	2.4
12	1.0

Duct diameters upstream from flow disturbance (A):	1.83	Limit: 0.5
Duct diameters downstream from flow disturbance (B):	3.13	Limit: 2.0

Figure 11 – Green Mill calculation of Duct Area and stack sampling point determination

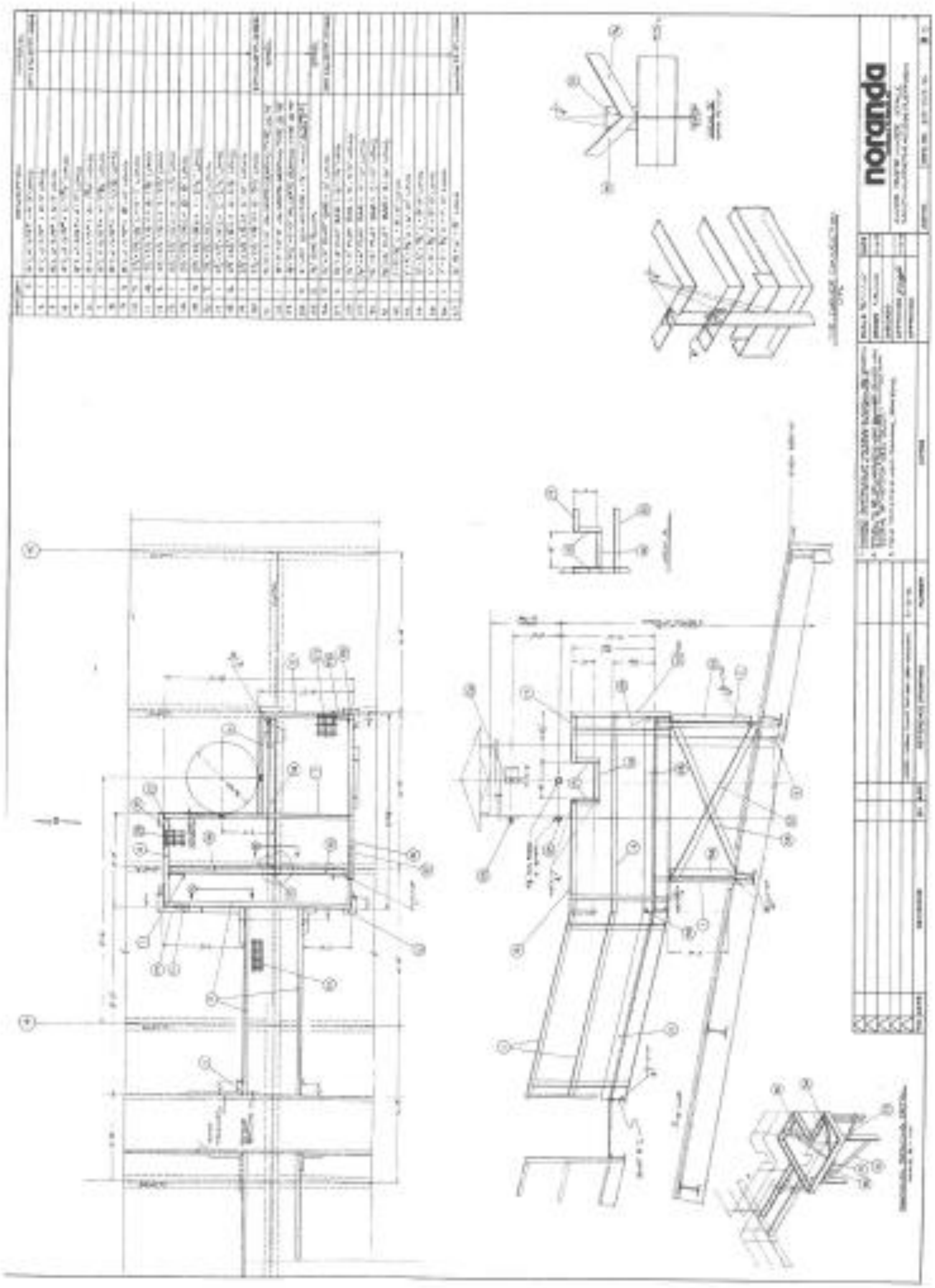


Figure 12 – Green Mill Sample Port locations